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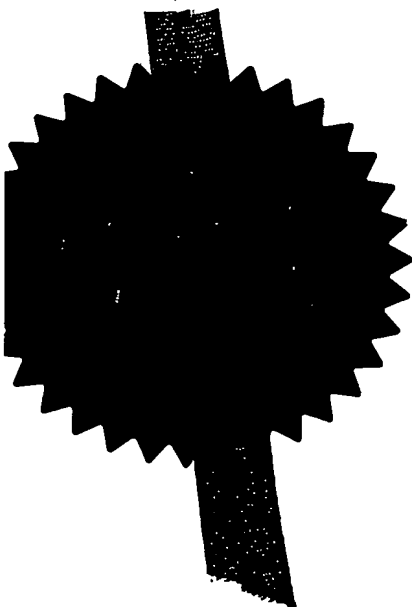
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4. Title of the invention

A Structural Composite Material for Acoustic Damping

5. Name of your agent *(if you have one)*

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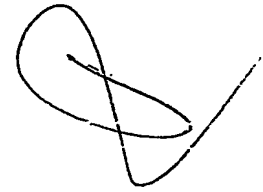
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A STRUCTURAL COMPOSITE MATERIAL FOR ACOUSTIC DAMPING

The present invention relates to a composite material for acoustic and mechanical damping and methods for its production. In particular, the present invention relates to 5 such material having advantageous static and dynamic characteristics. That is, the material should be strong and stiff enough to be formed into structural components and to bear a static load, while being capable of effectively absorbing acoustic and/or mechanical vibrations. It should also be rigid enough in order to restrict flexural deformations when the structure is loaded.

10

The composite materials in question typically have a layered structure. One common example comprises layers of glass fibre matting or non-crimped fabric embedded within an epoxy resin. Such material has a high static strength, but a poor dynamic performance. That is, such material is structurally strong, but has very poor acoustic or 15 mechanical wave damping characteristics.

In many situations, it is required to provide a material which is structurally strong and stiff, provides efficient damping of acoustic and/or mechanical vibrations but is lightweight. For certain applications, it is desirable that such material should also be 20 non-magnetic and capable of meeting fire and flame spread standard tests such as UL 94V0.

A material known to have good static and dynamic properties is a metal-rubber-metal sandwich structure. Typically, the relative thicknesses of the layers are 4:1:1. The 25 thickness of the rubber layer should be at least half the wavelength of the lowest frequency which is required to be damped. Such material does not provide the characteristics required of the present invention. It is not lightweight, the metal is typically steel for cost considerations and so is typically magnetic, and the structure is liable to delamination at the interfaces of the metal and rubber layers.

30

- 2 -

The present invention accordingly provides a stiff, lightweight material with effective damping properties for acoustic and/or mechanical vibrations, which is resistant to delaminations and is non-magnetic if necessary. Such material is preferably also available at low cost.

5

More particularly, the present invention provides a composite material for acoustic or mechanical damping, comprising: a plurality of layers of fibrous material embedded in a solid material. A layer of high hysteretic loss material is provided between consecutive layers of fibrous material, said layer of high hysteretic loss film being
10 bonded to the adjacent layers of fibrous material embedded in a solid material.

The layer of high hysteretic loss material may be perforated. In this case, the solid material may be continuous through the perforations between the adjacent layers of fibrous material embedded in a solid material. The perforations may occupy 5-30% of
15 the area of the layer of high hysteretic loss material.

In an embodiment of the invention, the solid material comprises an epoxy or polyester resin; the high hysteretic loss material comprises polyurethane film; and the fibrous material is glass fibre matting.

20

The present invention also provides a method for producing a composite material for acoustic or mechanical damping. The method comprises the steps of: providing at least one first, fibrous, layer impregnated with a first thermosetting material; stacking the at least one first, fibrous, layer on a former; providing at least one second layer
25 comprising a material of high hysteretic loss; stacking the at least one second layer on the stack of the first, fibrous, layer(s); providing at least one third, fibrous, layer impregnated with a second thermosetting material; stacking the at least one third layer on the stack of first and second layers; and simultaneously heating and compressing the
30 resulting stack of first, second and third layers to harden the thermosetting materials and to cause the material of the second layer(s) to bond with both the first and third layers.

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The method may further comprise the step of perforating the second layer(s) prior to the step of stacking the second layer(s). The step of perforating may comprise forming perforations which occupy 5-30% of the area of the second layer(s).

5

The method may further comprise the step of selecting the direction of the fibres and fibre types in the layers to provide a desired combination of structural strength, stiffness and damping properties.

10 The second layer may comprise a film of viscoelastic polymer film material.

The step of compressing may be performed by enclosing the stack in a heat-shrinking material prior to the heating step. The heat shrinking material may be polyamide tape.

15 The first and/or second thermosetting material may each comprise an epoxy, polyester or phenolic resin. The high hysteretic loss material may comprise polyurethane. The fibrous layers may comprise glass fibre matting.

The present invention also provides a method for producing a composite material with
20 acoustic damping characteristics. The method comprising the steps of providing at least one first, fibrous, layer impregnated with a first thermosetting material; stacking at least one first, fibrous, layer on a former; providing at least one second layer comprising a material of high hysteretic loss; stacking the at least one second layer on the stack of first, fibrous, layer(s); providing at least one third, fibrous, layer
25 impregnated with a second thermosetting material; stacking the at least one third, fibrous, layer on the stack of first and second layers; and simultaneously heating and compressing the resulting stack of first, second and third layers to harden the thermosetting materials.

30 The layer of high hysteretic loss preferably comprises a polymer film material.

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The heating and compressing step is effective to cause good bonding and interfacial strengths between the layers. By increasing the temperature is also possible to diffuse or intermingle the polymer film material, typically comprising a thermoplastic film polymer, into the thermosetting matrix of the structural layers, thereby increasing the strength of the resulting structure and reducing the abruptness of the junctions between first and second layers and second and third layers.

The first and/or second thermosetting material may comprise an epoxy or polyester resin. The second layer may comprise polyurethane or other polymer film. The fibrous layers may comprise glass fibre matting or non-crimped fabric. For applications where electrical insulation is not required it is possible to stiffen the material by replacing the whole or part of the glass reinforcement with a higher stiffness fibre such as carbon or aramid.

15 The method may further comprise the step of selecting the direction of the fibres of the fibrous layers to provide a desired combination of structural strength, stiffness and damping properties.

The above, and further, objects, characteristics and features of the present invention will become more apparent from consideration of the following description of certain embodiments thereof, in conjunction with the accompanying drawings, wherein

Figs. 1A-3B show partially cross-sectional views of materials according to embodiments of the present invention;

25 Figs. 4-7 show woven fibrous layers suitable for inclusion in the material of the present invention;

Fig. 8 shows, in cut-away plan view, several non-crimped fibrous layers of an embodiment of the present invention; and

Fig. 9 shows comparative test results of a sample of the material of the present invention compared to a sample of conventional material.

- 5 -

Fig. 1A shows a material 10 according to an embodiment of the invention. The material comprises a number of fibrous layers 12. The illustrations of Figs 1A-3B are expanded in thickness for ease of understanding. In reality, the fibrous layers 12 will be more closely packed than shown in the drawings. Each of the fibrous layers may
5 comprise a woven or non-crimped fibrous material, such as a glass fibre cloth, or carbon fibre matting, KEVLAR (TM) or steel mesh, or any other structurally strong fibrous material. Such materials are selected according to the intended final application. The fibrous layers are embedded within respective layers of a solid material 14.

10 The solid material 14 comprises a structural composite resin. Examples of the structural composite resin include epoxy, polyester, vinyl ester, phenolic and polyurethane resins.

A material of high hysteretic loss is provided at an intermediate layer 24. Examples of the material of high hysteretic loss material include polyurethane, polyesters,
15 polyethylene and other polymer matrices.

The inventors have found that epoxy resin is an inexpensive but effective structural composite resin for the layers of solid material 14. The inventors have also found that polyurethane is an inexpensive yet effective material for the material of high hysteretic
20 loss 24. The inventors have also found that glass fibre non-crimped cloth is an inexpensive but effective material for the fibrous layers 12. These materials will be referred to throughout the present description. However, such references are not to be construed as limiting and other materials, such as those listed above, may be used provided that they have the required properties.

25

The composite material of the present invention has acoustic or mechanical damping properties. It comprises a plurality of layers of fibrous material 12 embedded in a solid material 14. Preferably, the solid material comprises a composite including a matrix resin, which can be any suitable thermosetting laminating resin based on epoxies,
30 phenolics, polyesters or vinyl esters. The reinforcing fibres can be glass, carbon or polymer based. The damping properties are provided, according to an aspect of the

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present invention, laminating films 24 of a high hysteretic loss material, such as a thermoplastic material, between layers of the rigid composite 14. This thermoplastic material may be based on polyester or polyester based polyurethanes, polyethylene, PVC or copolymers, for example. The film 24 is typically 50 - 400µm thick.

5

For high strength products good bonding between the thermoplastic film 24 and the solid material 14 is promoted by ensuring the absence of internal release agents during processing of the material of layer 24 and / or by the use of corona treatment applied to the sheet surfaces.

10

The embodiment shown in Fig. 1A mimics the 4:1:1 relative thickness ratio known from the prior art metal:rubber:metal structures. Intermediate layer 24 has a relatively low, in this case down to 0%, proportion of the structural composite resin, and a relatively high, in this case up to 100%, proportion of the high hysteretic loss material.

15

Fig. 1B shows an alternative embodiment of the present invention. The embodiment of Fig. 1B differs from the embodiment of Fig. 1A in that perforations 34 are provided in the material of layer 24. During compression of the material, prior to the hardening of the thermosetting materials of layers 14, the perforations 34 fill with thermosetting material of layers 14, providing a continuous artefact of solid material 14. The perforations 34 may be of any suitable size or shape. For example, they may be square, circular, elongate, triangular or hexagonal. They may be regularly or irregularly spaced. Where the interlaminar shear strength has to be maximised, the perforation of the thermoplastic sheeting 24 with a regular pattern of 5-30 area percent of holes can be provided without compromising the enhanced damping characteristics. Indeed at some frequencies the damping is further enhanced by the inclusion of such perforations.

By using perforations in the polymer film material a continuous film-to-composite interface is avoided. This fuzzy interface avoids the problem of low laminate shear strength, whereby known laminates including a damping layer were liable to

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delaminate due to the high shear stresses occurring at the interface between the structural layers and the damping layer. High flexural strengths and stiffnesses are retained whilst at the same time, excellent acoustic damping characteristics are maintained. Indeed enhanced shear strain at the boundaries of the film holes which during processing are filled with matrix resin acts as to increase the damping at certain frequencies.

In use, the rigid composite regions 14 provide high structural strength and stiffness. The high damping is a result of hysteretic loss in the thermoplastic film layer 24. The material of the invention may be used for soundproof cladding, in which the need only be self-supporting, or may be structural in the sense of bearing a significant static applied load. The majority of the applied static load will be borne by the thicker layer 26 of the solid material 14, and the materials of the solid 14 and the fibrous layers 12 should be chosen and dimensioned according to the required mechanical strength. The perforated film layer 24 functions as an absorber of acoustic or mechanical vibrations. Upper layer 28 provides a hard outer surface, allows the intermediate layer 24 to function, as will be described below, and may act as a receiver of the vibrations to be damped. Upper and/or lower surfaces 20, 22 may be provided with a decorative layer integral to the material 10.

20

When an acoustic or mechanical vibration is applied to the solid upper layer 28, such layer transmits the vibrations through to the layer 24. The upper layer 28 will flex to some extent under the influence of the vibrations. Such flexing will cause tension within the fibres of the fibrous layers 12. These fibrous layers will disperse the stresses in layer 28 caused by the acoustic or mechanical vibration over a larger area of the upper layer 28, than would be the case in the absence of the fibrous material, or through an area of choice through careful fibre lay-up design. The solid layer 28 conveys the vibration of this larger, or chosen, area of upper layer 28 to a correspondingly sized portion of the high hysteretic loss layer 24. Thus, the fibrous layers 12 function to spread the applied vibrations over a larger, or chosen, area of layers 28 and 24. This is in addition to their well-known properties of adding structural stiffness and strength.

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The film layer 24 comprises materials with a relatively high hysteretic loss. Such materials will absorb a large proportion of the applied vibration, converting it into a small amount of heat. Very little of the originally applied vibration will reach the structural layer 26, and the material has accordingly performed its intended function of 5 damping the applied vibrations. Similarly, acoustic or mechanical vibrations applied to the structural layer 26 will be damped by layer 24, and very little of the applied vibration will reach the upper layer 28.

The characteristic path length of layer 24 should be at least equal to one-half of the 10 wavelength of the lowest frequency vibration which it is intended to damp. Typically, the material of the present invention may be made to effectively damp acoustic waves of 200Hz and above, while having a path length in the range of 4-12mm.

The particular composition and dimensions described with reference to Figs. 1A-1B are 15 only one example of the type of materials provided by the present invention. Further examples are described below.

An example of a method for producing the material of Fig. 1A will now be described. A former is first provided. This may be in the form of a flat surface, or may be in the 20 form of a contoured article to be produced in the material of the invention. A first layer 26 of fibrous material 12 is impregnated with the structural composite resin, such as an epoxy resin, and the layer is applied to the former. Where high drape is required the fibrous material 12 is chosen with good drape characteristics. Chopped strand mat, non-woven felt or $\pm 45^\circ$ non-crimped fabric petals have been found to be effective. 25 Further such layers may be stacked onto the first such layer. At least one layer of high hysteretic loss film material 24, such as polyurethane, is laid onto the first layer(s). The film layer may be perforated 34, as illustrated in Fig. 1B, or continuous, as illustrated in Fig. 1A. Further such layers may be applied. Finally, at least one further layer of fibrous material 12 is impregnated with a structural composite resin, such as an epoxy 30 resin, and is laid over the stack of layers described. The resulting assembly will be a

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"sandwich" structure, having layers of high hysteretic loss film material 24, such as polyurethane, enclosed between layers 26, 28 of fibrous material 12 impregnated with structural composite resin, such as an epoxy resin. The materials used for the structural composite resin of layers 26 and 28 may be different from each other, or may be the same.

The resulting assembly is then compressed and heated, according to techniques known in themselves, to cure the solid materials 14, such as epoxy resin. The high hysteretic loss material 24 may be either left intact during this operation if temperatures less than the film material's melting point are used in processing; alternatively the film 24 may be partially melted and partially dispersed into the more rigid composite structure 14, 12, if the heating step reaches a sufficiently high temperature. The structure can be further heated to post cure the structural composite resin(s).

The resulting structure is then allowed to cool and is removed from the former. Decorative layers 20, 22 may be applied as the first and/or last layers in the stack of fibrous layers. The compressing step may be performed by applying an upper former to the assembly of fibrous layers and applying pressure. The former(s) may each have a decorative pattern 20, 22 applied which may be transferred to the structure of the material of the present invention. The compressing step may alternatively be performed by enclosing the stack of layers within a further layer of a material which is relatively inert, but which shrinks at the temperatures required for curing. A vacuum may be applied to an outer polymer film to consolidate the component through its thickness. The inventors have found that a polyamide cloth tape is suitable for this purpose.

The compressing step may be performed by any suitable method, such as by application of a press, or an inflatable cuff, or by vacuum bagging.

- 10 -

An increased applied pressure will tend to enhance the bonding between the structural resin (e.g. epoxy) and the high hysteretic loss film material (e.g. polyurethane) and also increase the fibre volume fraction in the composite.

5 Figs. 2A and 2B show material 401 according to further embodiments of the present invention. The material 401 differs from the material 10 of Figs. 1A-1B in that the layer 24 is placed substantially centrally within the structure, and that layer has an increased thickness as compared to the material 10 of Figs 1A-1B. This embodiment demonstrates that the relative position and thickness of the layers 26, 28 may be varied
10 at will, in order to achieve a desired set of static and dynamic characteristics. The material of Figs 2A and 2B maybe expected to have a lower static (structural) strength than the material of Figs. 1A-1B, but to provide a more effective dynamic characteristic, that is, to be more effective at damping acoustic and mechanical vibrations.

15

Figs. 3A and 3B show a material 601 according to further embodiments of the present invention. The material of Figs 3A and 3B differs from the materials of previous embodiments principally in that a plurality of layers 24 of material of high hysteretic loss are provided. Such plurality of layers are separated by separating layers 30 of
20 solid material comprising fibrous material 12 and an epoxy resin, or other structural composite resin, as for layers 26, 28. Such material 601 may be produced by a method similar to that described for the material of Figs 1A and 1B, but in which one or more layers of epoxy impregnated fibrous material 12 is placed between groups of at least one high hysteretic loss film layer 24.

25

The material of Figs 3A, 3B may be expected to have a significantly improved dynamic (vibration-damping) characteristic as compared to a similar material having a single layer 24 of thickness equal to the sum of the thicknesses of the layers 24 of Fig. 1A.

30 As illustrated in Fig. 3B, the perforations 34 in the various layers 30 may be of differing sizes, spacing, shapes and orientations. One may select the characteristics of

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the perforations in each layer to provide a desired damping performance. The perforations may be irregularly spaced in any layer 30, again to provide a desired damping performance.

5 As described earlier, one of the functions of the fibrous layers 12 is to disperse the applied vibrations over an increased surface area of the epoxy (structural composite resin) layer 26, 28, 30 receiving the vibrations. This occurs by the vibrations causing flexing of the epoxy layer, which in turn causes tension in the fibres of the layers 12, which causes tension in regions of the fibrous layers distant from the original point of
10 application of the vibration to the fibres. This causes the applied vibration to be spread over a wider area of the damping layer 24, increasing the overall damping efficiency. This function of spreading the tension can only occur in the direction of the fibres.

Fig. 4 shows a typical fibrous material suitable for use as the fibrous layers 12 in the
15 material according to the invention. A fibrous material, for example, glass fibre cloth, is woven or stitched in separate non-crimped layers with strands at 0° and 90° to the direction of feed of the material as it is applied. Use of this material will allow stresses applied at a certain point to be dispersed at angles of 0° and 90° from the point of impact.

20

Similarly, Fig. 5 shows another fibrous material suitable for use as the fibrous layers in the material according to the invention. The fibrous material, for example, glass fibre cloth, is woven with strands at 45° and 135° to the direction of feed of the material as it is applied. Use of this material will allow stresses applied at a certain point to be
25 dispersed at angles of 45° and 135° from the point of impact.

Similarly, Fig. 6 shows another fibrous material suitable for use as the fibrous layers in the material according to the invention. The fibrous material, for example, glass fibre cloth, is woven with strands at 30° and 120° to the direction of feed of the material as it

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is applied. Use of this material will allow stresses applied at a certain point to be disposed at angles of 30° and 120° from the point of impact.

According to an aspect of the present invention, use of a certain combination of such materials as the various fibrous layers 12 of the material of the invention allows applied stresses to be spread from the point of application in multiple directions, increasing the efficiency of spreading, and correspondingly increasing the effectiveness of the material's vibration damping properties.

10 According to the desired application, a product produced in the material of the invention may have preferred directions in which stresses could be applied. Stresses could be preferentially directed in those directions by carefully selecting and/or aligning the fibrous material used in the fibrous layers, for example, those shown in Figs. 4-6. For materials subjected to hydrostatic pressure a quasi-isotropic lay-up 15 through each point of the component thickness is most appropriate.

Fig. 7 shows a further fibrous material suitable for use as the fibrous layer of the material of the invention. In this material, which may alternatively be orientated similarly to that shown in Figs 5-6, or otherwise, one direction of the weave has a significantly greater density of fibres than the other direction. Since tension is transmitted within the layers of the material of the invention along the fibres of the fibrous material, the use of the fibrous material of Fig. 7 will preferentially transmit stresses in the direction of the higher density of fibres. By appropriately selecting and aligning such a fibrous material as one or more of the fibrous layers within the material 25 of the invention, stresses caused by applied acoustic or mechanical vibrations may be preferentially dispersed in selected directions. The requirement for such functionality will be determined by the required characteristics of the article being produced from the material of the present invention.

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Fig. 8 illustrates, in cut-away, the fibrous materials of various layers of a sample of material according to the present invention. As can be seen, fibrous material according to each of Figs. 4-7 has been included, as respective fibrous layers 12 within the material. This will provide a particular, and relatively complex, pattern of dispersion of applied stress. It would be unusual to require such a number of different fibrous materials within one sample of the inventive material, and a maximum of two or three different types of material or orientation would be typical.

Fig. 9 shows results of tests performed on a sample of the material of the present invention. Vibrations varying in frequency from 0Hz to 2557Hz were applied to a sample of the material according to the invention, and a sample of conventional GRP, that is, epoxy resin containing glass fibre matting. Curve 50 shows the amplitude of vibration of the sample of conventional GRP over the range of applied frequencies, while curve 60 shows the corresponding amplitude of vibration of the sample of material of the invention over the same range of frequencies. As can be seen, the material of the present invention provides very effective damping of vibration at audio frequencies. At frequencies below about 220Hz, the material of the invention is not effective at damping. This is because the damping layers 24 of the sample had a thickness less than half a wavelength of frequencies of 220Hz and below. This could be cured, if necessary for the intended application of the material, by increasing the thickness of the damping layer 24.

The invention accordingly provides an inexpensive, rigid, lightweight damping material which is resistant to delamination and is also preferably non-magnetic.

25

Although certain specific materials have been disclosed, these are not limiting and many other materials may be used, depending on cost, the required mechanical characteristics and the required application of the resultant material. The fibrous layer 12 may be composed of conductive material such as carbon fibre or steel mesh, for example to provide RF screening. The fibrous layers 12 may be composed of respectively different materials, or a fibrous material comprising elements of different

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materials, such as glass fibre, carbon fibre, polymer fibre, aramid, copper, steel, may be specially produced and used for particular applications.

The material provided by the present invention finds many industrial applications. For
5 example, automotive dashboards made from the inventive material would reduce noise transmission and would be less likely to rattle. Automotive body parts and other items, such as rudders for boats, may be made from the material of the invention to provide a "luxury" feel, without adding to weight. The mechanical and acoustic damping properties of the material of the invention will mean that such parts do not easily
10 resonate, and behave much as a heavy metal component of much greater mass would behave. Turbine blades could be constructed from the material of the invention. The properties of the material may be varied by using different combinations and compositions of layers, for example to provide very effective damping at the tips of turbine blades, to prevent mechanical resonance, combined with high structural
15 strength toward the centre of the turbine blade to provide a strong mounting point. Dampers may be made from the material of the invention, for example, to prevent oscillation of structural steel wires under tension.

Further possible applications include lightweight transmission shafts for vehicles, MRI
20 (magneto-resonance imaging) magnet gradient housing; MRI magnet gradient vacuum housing; aircraft engine cowl; aircraft engine supporting structure; airframe parts, primary or secondary; control of flutter in flying surfaces; housing for other equipment, e.g., road drill mining/construction equipment; damping oscillation in automatic systems; changing the load response and geometry response of structures to optimise
25 stress and deflection in design of structures to meet static and or dynamic requirements; improved performance in powder delivery systems; reduction of vehicle noise in motor cars, trains, aeroplanes etc.

The invention accordingly provides a composite construct which can be tuned to
30 deliver the desired blend of structural and dynamic properties, to control or reduce vibration, in terms of amplitude of vibration and the number of dominant frequencies of

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vibration, in a structure covering or mounting a source of vibration. Particular static and/or dynamic stress requirements in the design of housings or structures may be met by changing the load response and geometry response of structures, according to certain aspects of the invention. The material of the invention may be adapted to have
5 a low strength but a high damping for use in no- or low-stress applications. Alternatively, the material of the invention may be adapted to have very high structural strength, but with damping characteristics much improved over known materials. The overall level of noise and vibration emitted from a structure of the present invention may be reduced to 10%-20% that emitted from a similar structure of conventional
10 materials such as epoxy resin and glass fibre alone. In the specifically described example, a composite of fibreglass with epoxy resin has perforated thermoplastic polyurethane film layers dispersed between each layer of epoxy resin and glass fibre, such that the structural properties exceed those available in materials exhibiting a similar level of damping, while also exhibiting damping properties which exceed those
15 available in materials exhibiting similar mechanical strength. By a process of placing and adjusting the level and thickness of the film, and the size, shape and position of any perforations it may have, the amplitude of noise and vibration can be reduced and the total number of dominant frequencies in a band of frequencies can be reduced to "tune" a structure. In the same way, it is also possible to simultaneously achieve mechanical
20 strength required to design a thin walled vessel for use in, for example, MRI (magneto-resonance imaging) equipment. Such level of combined strength and damping has not previously been observed in the prior art.

The optional provision of pure epoxy/glass or metal layer on one surface of the
25 damping zone may prevent outgassing into a vacuum. Similarly, such still layers may be advantageously applied to highly loaded extreme fibres of the material of the invention.

The mechanical strength of the material may also be increased by increasing the
30 density of the fibrous material, either by providing more layers of fibrous material per unit depth, or by providing fibrous material of a denser weave.

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CLAIMS:

1. A composite material (10) for acoustic or mechanical damping, comprising: a plurality of layers of fibrous material (12) embedded in a solid material (14),
5 characterised in that a layer (24) of high hysteretic loss material is provided between consecutive layers of fibrous material, said layer (24) of high hysteretic loss material being bonded to the adjacent layers of fibrous material (12) embedded in a solid material (14).
- 10 2. A composite material according to claim 1 wherein the layer (24) of high hysteretic loss material is perforated, whereby the solid material (14) is continuous through the perforations (34) between the adjacent layers of fibrous material (12) embedded in a solid material (14).
- 15 3. A composite material according to claim 2 wherein the perforations occupy 5-30% of the area of the layer (24) of high hysteretic loss material.
4. A composite material according to any preceding claim wherein the solid material (14) comprises an epoxy or polyester resin; the high hysteretic loss material
20 (24) comprises polyurethane film; and the fibrous material (12) is glass fibre matting.
5. A method for producing a composite material (10) for acoustic or mechanical damping, comprising the steps of:
 - providing at least one first, fibrous, layer (12; 26) impregnated with a first
25 thermosetting material (14);
 - stacking the at least one first, fibrous, layer on a former;
 - providing at least one second layer (24) comprising a material of high hysteretic loss;
 - stacking the at least one second layer on the stack of the first, fibrous, layer(s);
 - providing at least one third, fibrous, layer impregnated with a second thermosetting
30 material;
 - stacking the at least one third layer on the stack of first and second layers; and

- 17 -

- simultaneously heating and compressing the resulting stack of first, second and third layers to harden the thermosetting materials and to cause the material of the second layer(s) to bond with both the first and third layers.

- 5 6. A method according to claim 5, further comprising the step of perforating the second layer(s) prior to the step of stacking the second layer(s).
7. A method according to claim 6 wherein the step of perforating comprises forming perforations with occupy 5-30% of the area of the second layer(s).
- 10
8. A method according to any of claims 5-7 wherein the second layer comprises a film of viscoelastic polymer film material.
9. A method according to any of claims 5-8 wherein the step of compressing is
15 performed by enclosing the stack in a heat-shrinking material prior to the heating step.
10. A method according to claim 9 wherein the heat shrinking material is polyamide tape.
- 20 11. A method according to any of claims 5-10 wherein the first and/or second thermosetting material comprises an epoxy, polyester or phenolic resin.
12. A method according to any of claims 5-11 wherein the high hysteretic loss layer
comprises polyurethane.
- 25
13. A method according to any of claims 5-12 wherein the fibrous layers (12) comprise glass fibre matting.
14. A method according to any of claims 5-13 further comprising the step of
30 selecting the direction of the fibres and fibre types in the layers to provide a desired combination of structural strength, stiffness and damping properties.

15. A material substantially as described and/or as illustrated in the accompanying drawings.

5 16. A method substantially as described.

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ABSTRACT

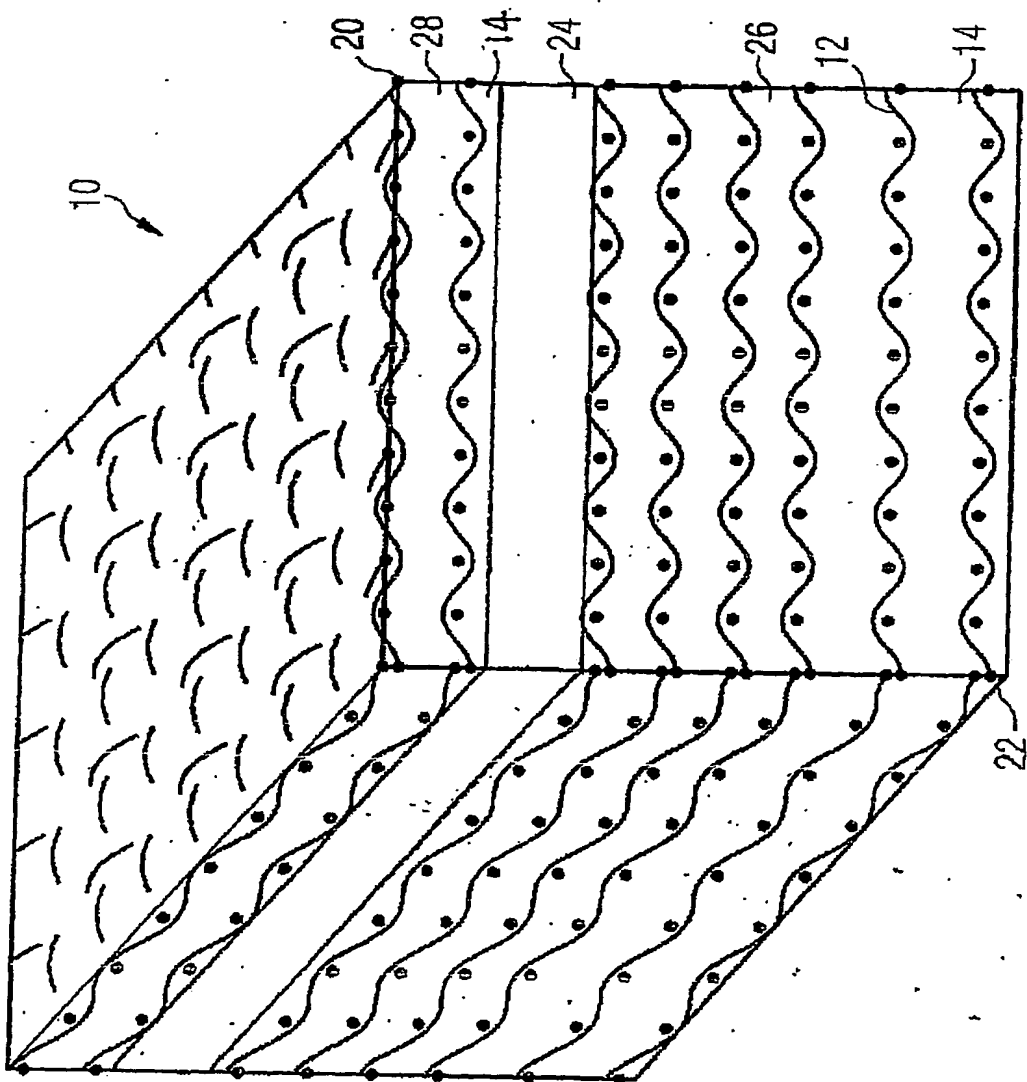
COMPOSITE MATERIAL FOR ACOUSTIC DAMPING

5 A composite material for acoustic or mechanical damping, comprising a plurality of layers of fibrous material embedded in a solid material. The solid material layers are interspersed by films of viscoelastic polymer which may be perforated or continuous.

[Fig. 1B]

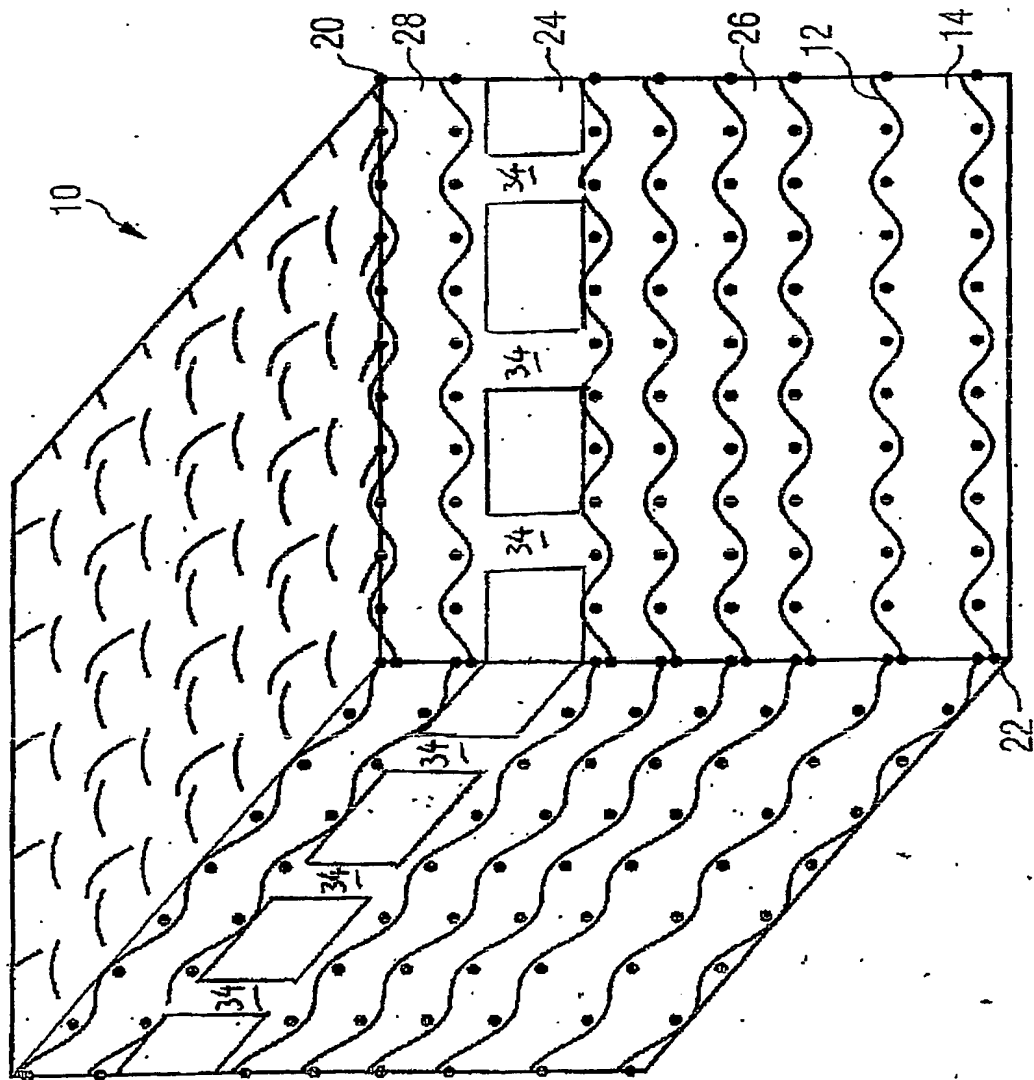
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FIG 1A



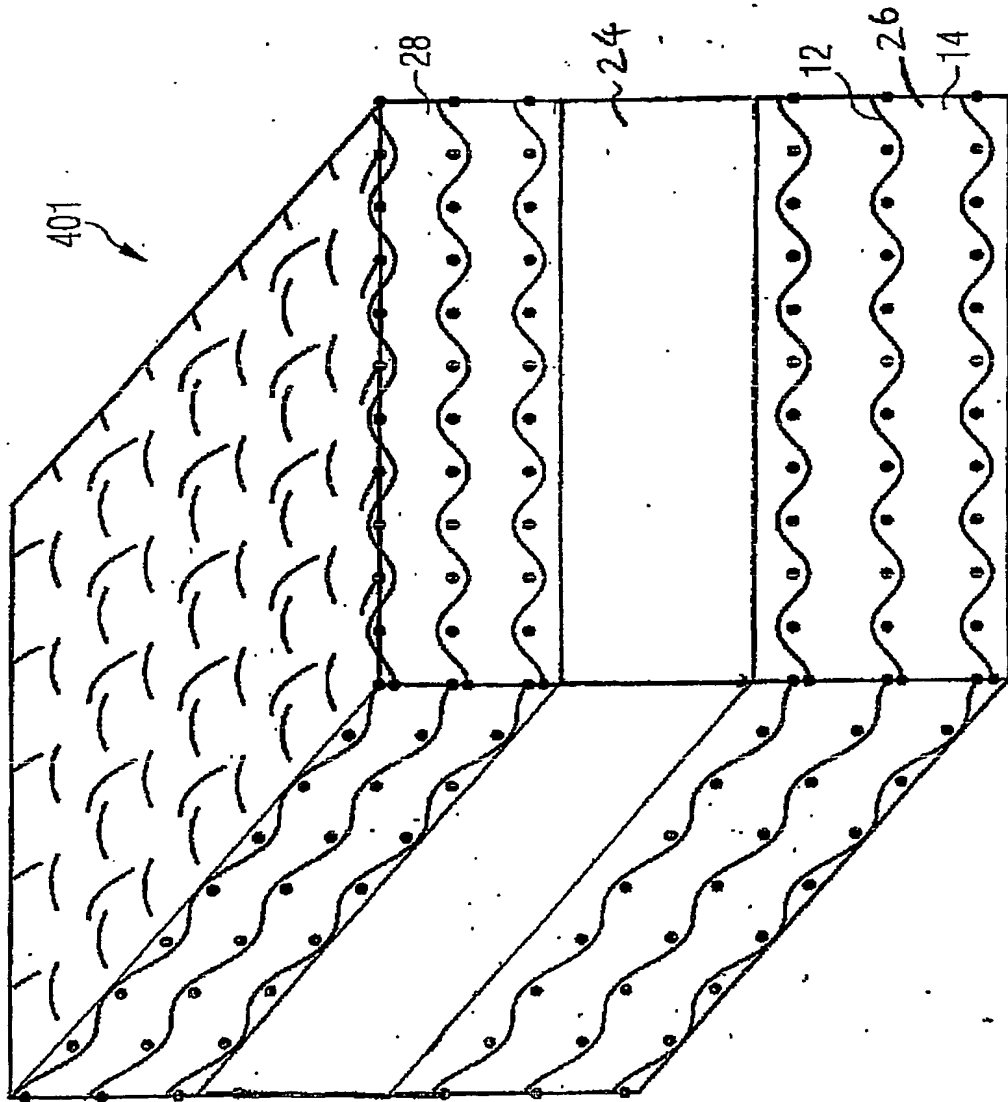
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FIG 1B



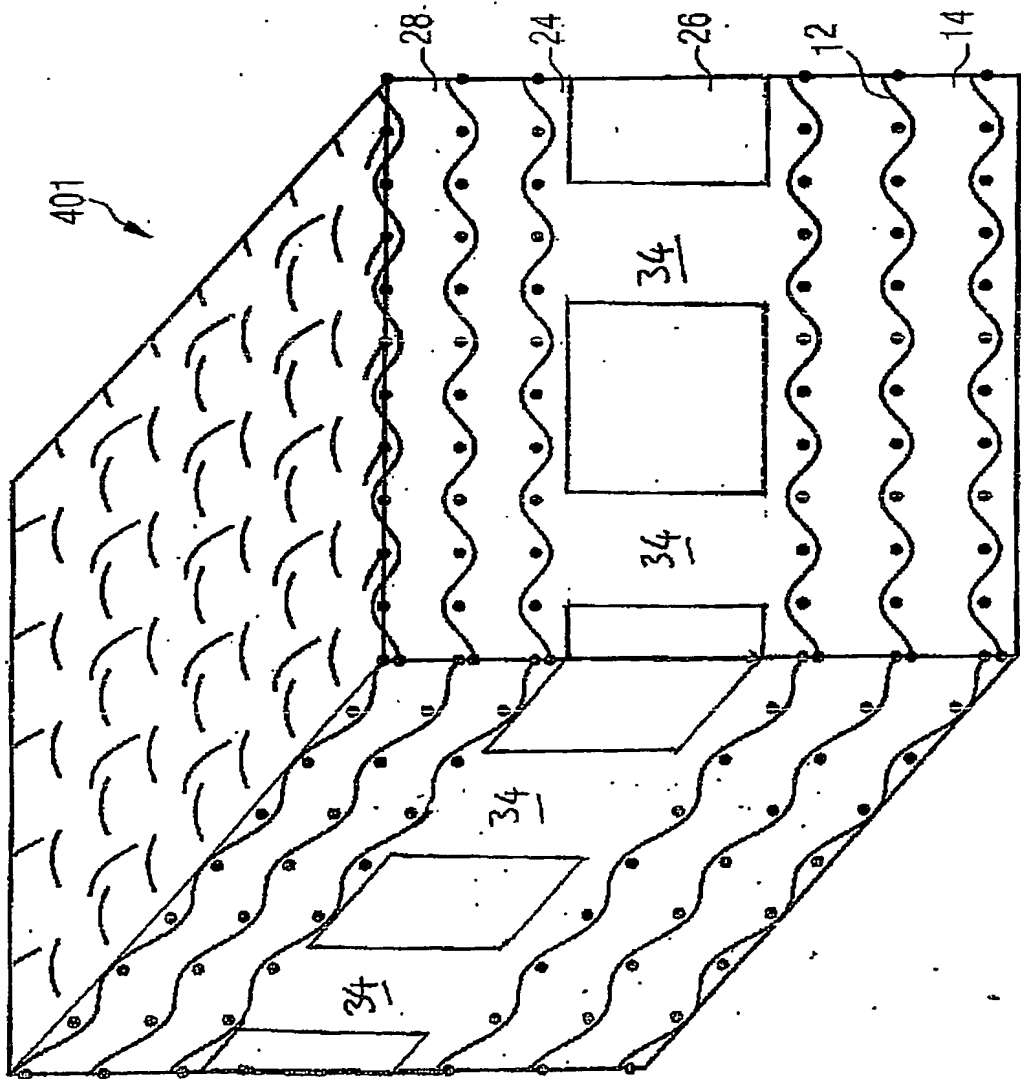
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FIG 2.A



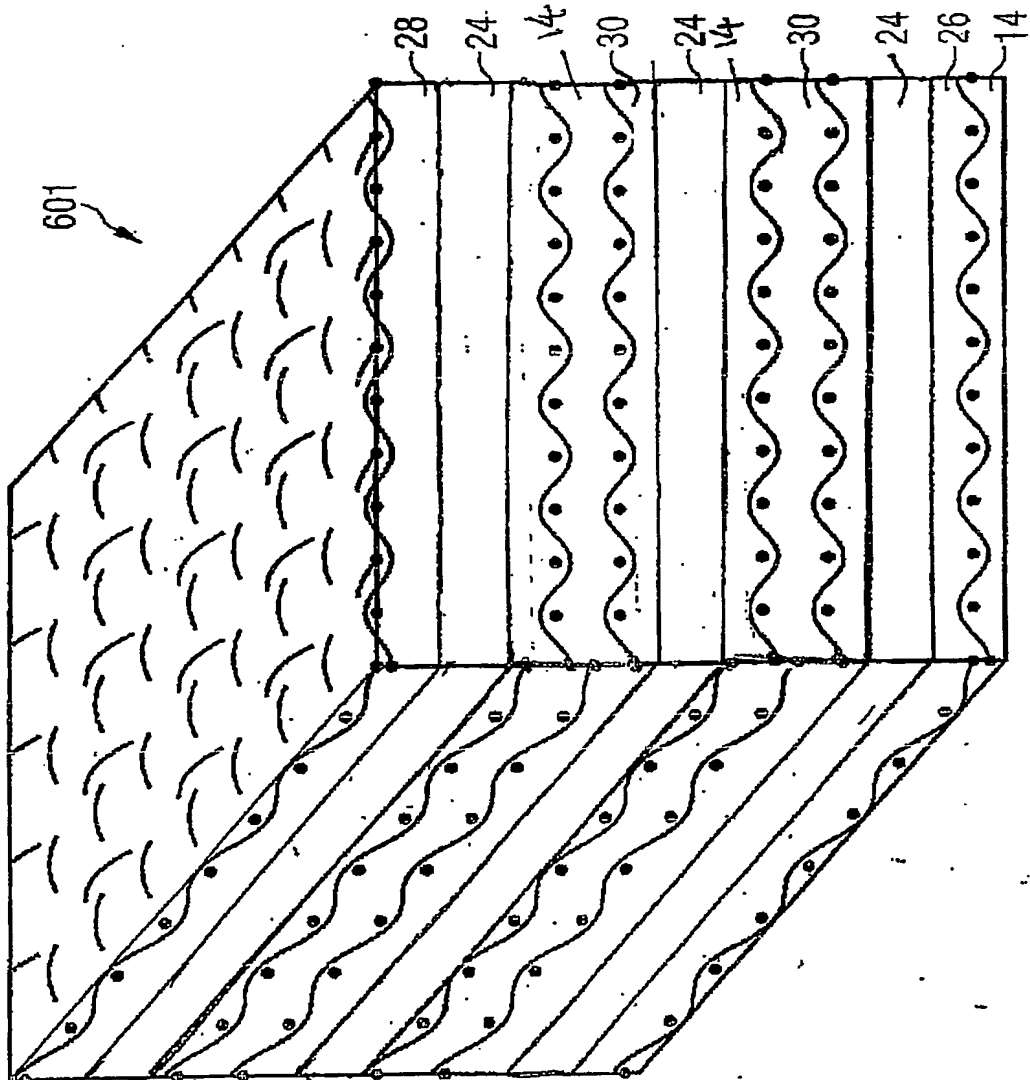
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FIG 2 B



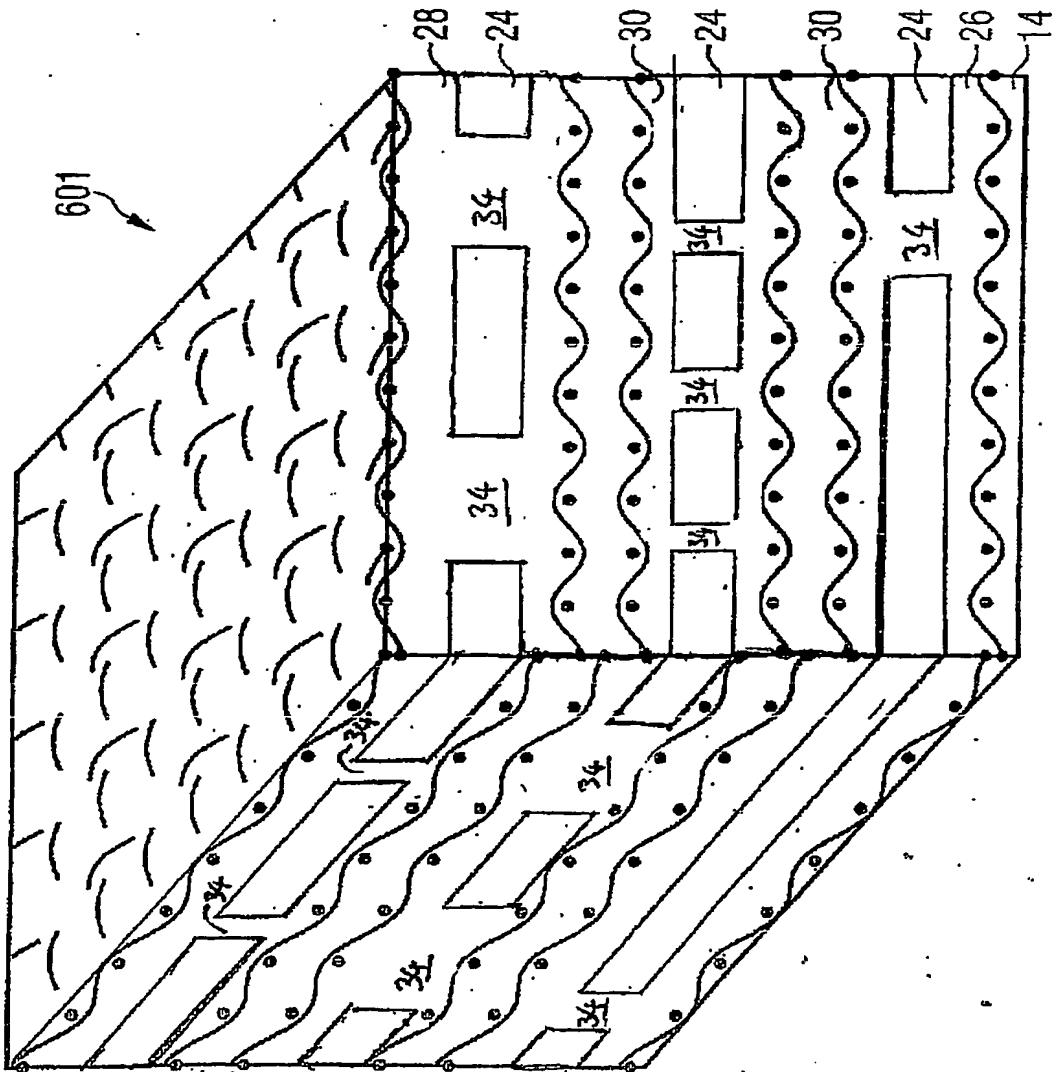
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FIG 3 A



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FIG 3 B



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FIG 4

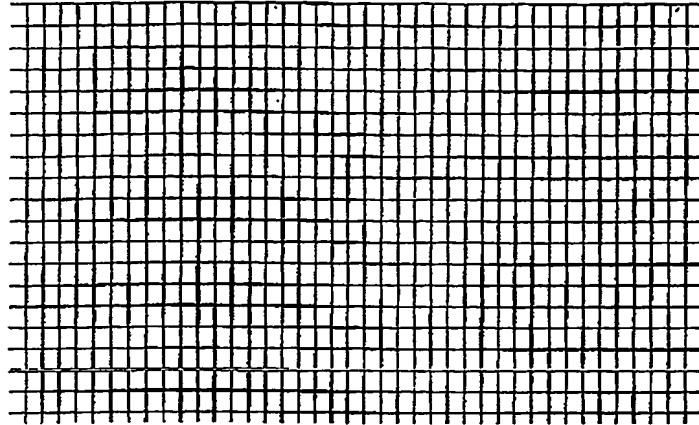


FIG 5

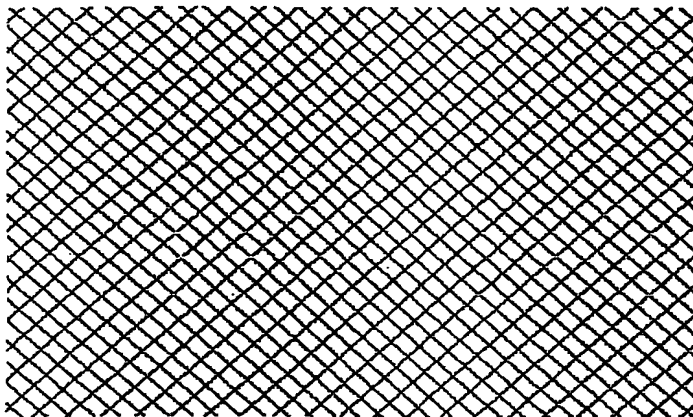
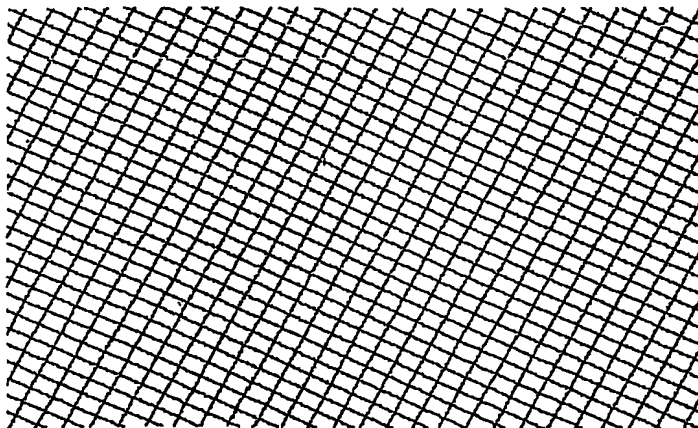


FIG 6



8(9)

FIG 7

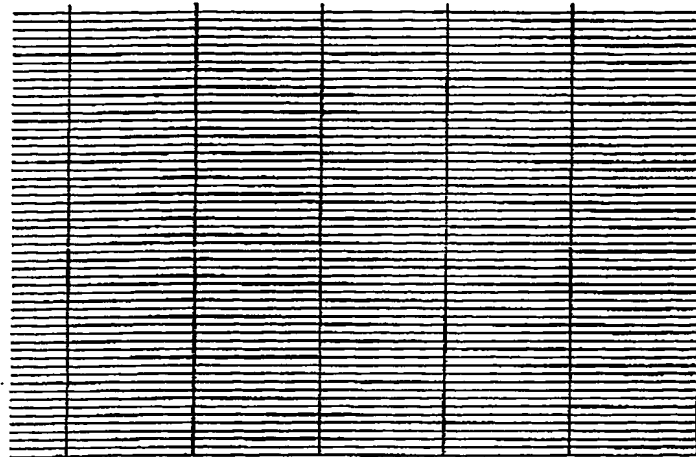
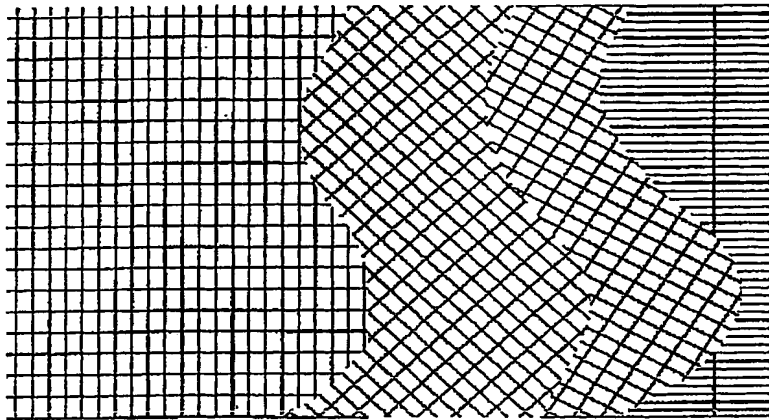


FIG 8



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